Land Use Guidelines
Mineral Exploration

Yukon and
Northwest Territories

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

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Preface

This booklet is a synthesis of techniques and guidelines for minimizing environmental damage during mineral exploration in Yukon and Northwest Territories. It contains information on a range of topics from how to apply for a Land Use Permit to proper procedures for abandoning an operational site. It is specifically designed to help operators to understand and comply with the Territorial Land Use Regulations, and in general to assist operators to carry out their activities so that the least amount of damage to the environment results.

The guidelines presented here are not legally binding; they simply represent good practices that should be followed by anyone exploring for minerals in northern Canada. They are based on current industrial practices and should not be regarded as the last word in environmental protection.

Some of the procedures outlined here will be required as part of the conditions attached to a Land Use Permit. Such Permits are required for most mineral exploration carried out in the Northwest Territories. In Yukon, however, Permits are required only for work carried on outside claim boundaries, or on claims held by another party.

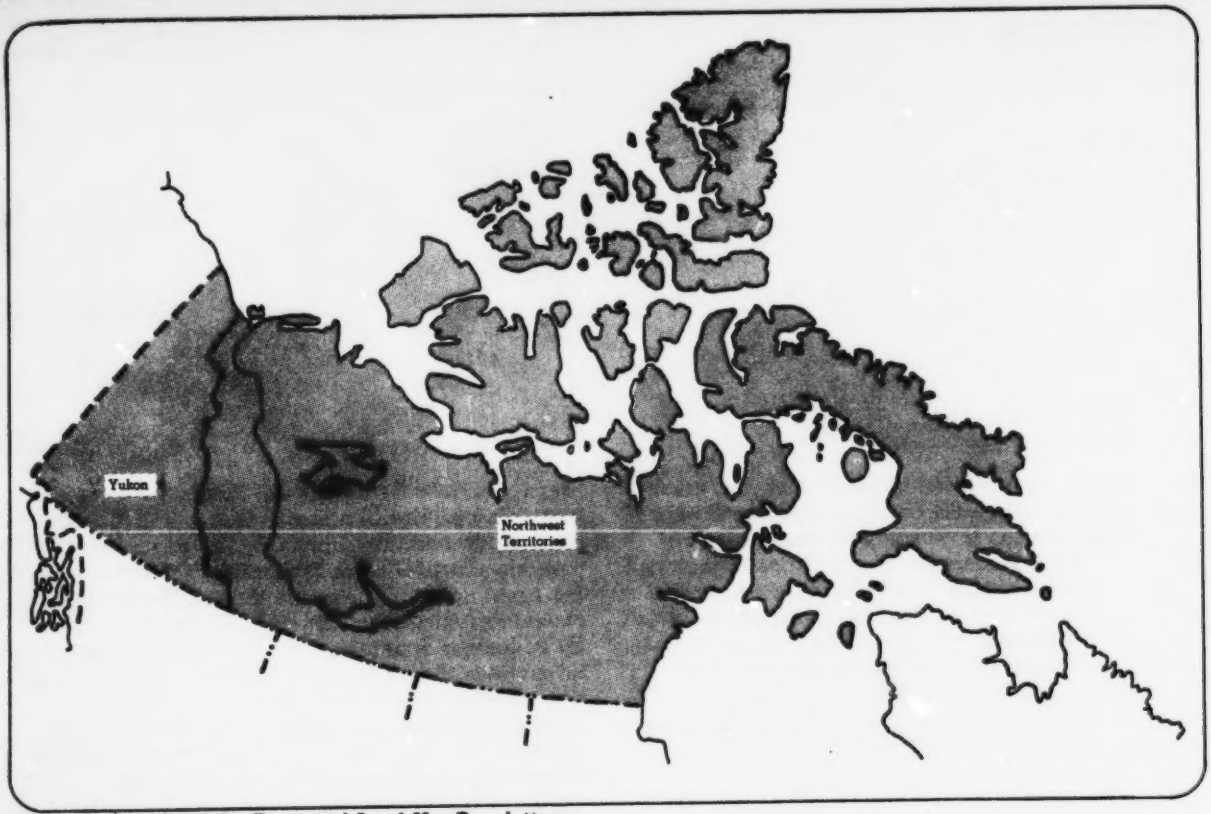
The booklet contains two main sections: Background to Environmental Protection, and Minimizing Environmental Damage.

"Background to Environmental Protection" covers points that an operator must know to find his way through the permitting process, and to properly plan his activities so as to minimize their effects on the environment. It discusses the rationale behind environmental protection programs, and the need for educating operational personnel in environmental matters. It also mentions major pieces of legislation affecting exploration, some practical aspects of Land Use Permits, how to apply for one, assisting an Inspector, and clearing a Permit when a project is over. Many conditions that are commonly attached to a Permit are also discussed.

"Minimizing Environmental Damage" addresses the environmental impacts that may result from exploration. Activities covered range from aircraft operations and access trail construction, to sewage discharge and fuel storage. It can be used to determine what problems may arise during exploration programs, and how to avoid them. Operators should consult this section before exploration begins.

While considerable effort has been expended to ensure that all probable impacts of exploration have been addressed, this booklet is not an all-encompassing review of the topic. Under unusual conditions, impacts not covered in this manual may occur.

A full explanation of some procedures for avoiding or reducing environmental impacts would require detailed instructions. Other techniques require site-specific adjustments if they are to be successfully applied, and many volumes of instructions would be needed to detail the adjustments necessary to cover the great diversity of conditions in northern Canada. In cases where space does not permit complete coverage of a procedure, readers should consult publications or other sources to obtain the necessary details.



General area where the Territorial Land Use Regulations apply

This booklet contains a list of Territorial and Federal government agencies that frequently have an interest in exploration programs. The primary responsibilities of each agency, in relation to exploration, are noted.

Many persons have contributed to this booklet. Its production was overseen by the Guidelines Steering Committee of the Department of Indian Affairs and Northern Development (DIAND). Chris Cuddy served as Chairman, and Martin Barnett was the Scientific Authority. Other members of the Committee included Floyd Adlem, Jack Hiscock, and Perry Savoie.

The staff and resources placed at our disposal by DIAND in Yukon and the Northwest Territories greatly facilitated our work.

Input we received from individuals in the mining industry was most helpful. Especially beneficial were our conversations with David Waugh of the Yukon Chamber of Mines, Paul Brown of Amoco, and John Fraser of the Northwest Territories Chamber of Mines.

PART 1
BACKGROUND TO ENVIRONMENTAL PROTECTION

Rationale for Environmental Protection

Measures to protect the environment are not intended simply to 'save some moose pasture'. They are designed to protect potentially valuable resources for the future.

It is unlikely that one exploration program would irreparably damage the environment of a large area, but we must remember that few programs operate in isolation. Several firms may explore a promising area simultaneously, or a succession of companies may explore at different times. Minor impacts can become serious problems if they are repeated several times.

Environmental protection benefits operators, as well as preserving the environment. Frequently, effective protection can be achieved by applying sound engineering principles. Well designed and constructed installations will maximize an operator's returns by reducing maintenance and repair costs, and increasing the operating life of facilities. Carefully routed and constructed roads rarely experience problems, but those that are simply driven through an area need continual repair, and may have to be re-routed or rebuilt.

Tundra access trail. The damaged terrain will require many years to repair itself.

Education and Training Programs

If protection plans are to be successfully implemented, all employees must be aware of new working procedures, and why they differ from former methods. Only if workers fully understand the how's and why's of new procedures will they be willing and able to effectively implement those procedures. To maintain the necessary awareness levels, all exploration staff must be informed. On-going training programs will be needed, so that new staff can be trained as they are hired.

Environmental protection programs that are clearly explained, well planned, and carefully implemented will yield major benefits for all parties involved with mineral exploration. This booklet should assist in creating and implementing the desired programs.

Methods that can be used to avoid or minimize many problems are outlined in this booklet. Additionally, conditions incorporated in the Land Use Permit will briefly outline ways to avoid difficulties that are expected to be encountered during a specific operation. Reading this booklet and the Conditions attached to a Permit will familiarize project personnel with the problems likely to be encountered during mineral exploration, and how to avoid them.

If unusual problems that cannot be handled by staff on an exploration project are encountered, assistance may be obtained from government agencies.

Legal and Practical Basis of Territorial Land Use Regulations

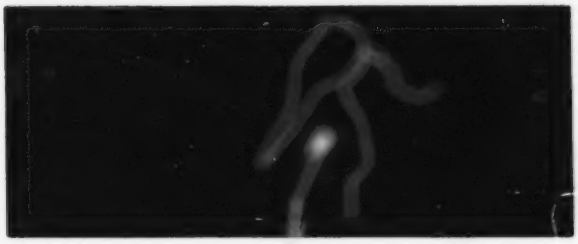
All activities involving occupation of, use of, or travel across Federal Crown lands in the Northwest and Yukon Territories may, at least potentially, be controlled under the Territorial Lands Act R.S.,c.233,s.1, and regulations issued under that Act.

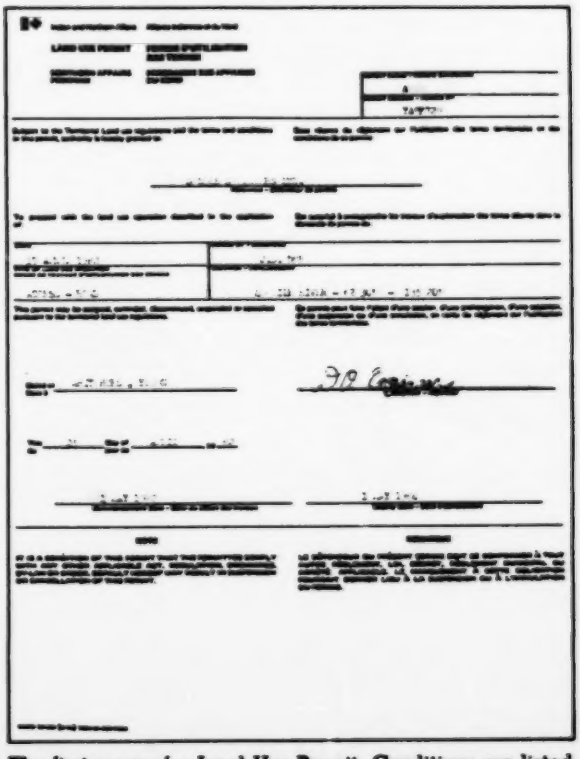
A process has been established under the Territorial Land Use Regulations to control land use activities in both Territories. An administrative guide that explains the process, outlines when a Land Use Permit is required, and details how to obtain one is available free of charge from DIAND offices.

Mineral exploration activities are controlled mainly through the Territorial Land Use Regulations. Under the Regulations, a Permit is required if:

- more than 50 kg of explosives are used in any 30 day period.
- vehicles used off publicly maintained roads and trails weigh more than 5 t, or exert a ground pressure of more than 35 kpa.
- fuel stores contain more than 2000 l in a single container, or 4000 l total.
- drilling machinery weighs more than 500 kg, excluding ancillary equipment.
- a camp used by more than two persons is occupied for more than 100 man-days.
- clearings for rights-of-way exceed 1.5 m in width.

In northern Canada, Land Use Permits are required for exploration on all lands except those whose surface rights have been totally disposed of by the Crown. Examples of excluded areas include private lands, National Parks, and roads.





The first page of a Land Use Permit. Conditions are listed on subsequent pages of the Permit.

Inspection

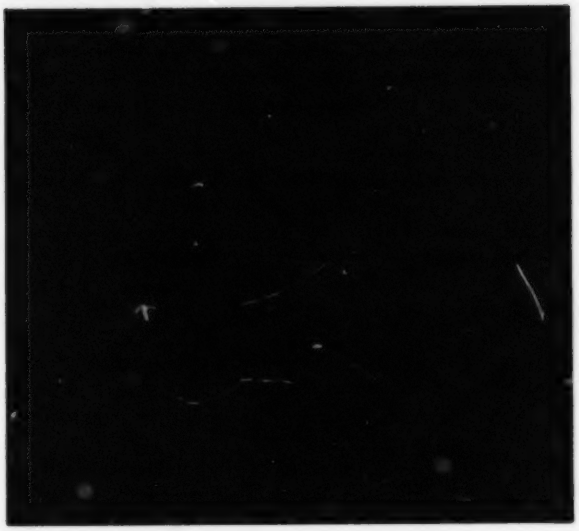
Land Use Inspectors are appointed under the Territorial Land Use Regulations to ensure that the conditions attached to a Land Use Permit are adhered to. Inspectors may visit an operation several times during a field season.

Inspectors have the right to enter and inspect all areas of a land use operation, except private dwellings. Operators are expected and required to help an Inspector carry out his duties, by providing information and assistance.

Get in touch with an Inspector if you can not comply with conditions of a Land Use Permit. The Inspector will probably be familiar with the problem, and able to offer assistance.

After each inspection, the Inspector will prepare a report summarizing his findings. A copy is given to the operator, who is expected to correct any conditions that do not comply with the Permit.

If an operator flagrantly or continually violates Permit conditions, an Inspector can suspend the operation. Besides being shut down, violators can be ordered to pay the costs of any action required to correct a problem, and they may also be prosecuted.



Other Applicable Legislation and Responsible Agencies

In addition to the Territorial Lands Act and Territorial Land Use Regulations, there are a number of Acts, Regulations, and ordinances that commonly apply to mineral exploration programs. It is the responsibility of the operator to ensure he complies with all applicable laws. If there is any confusion as to what legislation applies, the Northern Affairs Program staff will refer an operator to the appropriate agencies.

Some of the most applicable Acts, Regulations, and Ordinances are listed below.

- Fisheries Act
- Northern Inland Waters Act
- Navigable Waters Act
- Arctic Waters Pollution Prevention Act
- Timber Regulations
- Quarrying Regulations
- Dredging Regulations
- Public Health Ordinance
- Territorial Wildlife Ordinance

Agencies listed in the following table regulate mineral exploration. Their responsibilities relating to exploration are briefly outlined. It is also possible that other agencies might be involved in regulating some aspect of a program.

Government Agency	Responsibility
Department of Indian Affairs and Northern Development	Coordinating agency. Has overall responsibility for granting Permits and referrals to all other agencies.
Land Resources	Issue Land Use Permits, Quarrying Permits and surface leases.
Water Resources	Issue authorizations for water use, administer licenses issued by the Territorial Water Board.
Forest Resources	Regulate timber harvesting, issue burning permits, and prevent and suppress forest fires.
Mining Recorders	Register claims. Ensure proper staking, filing, and maintenance.
Department of the Environment	
Environmental Protection Service	Concentrates on safe waste disposal, protection of aquatic ecosystems, and administers the Clean Air Act.
Canadian Wildlife Service	Responsible for migratory birds. Mandate includes protection of nesting and staging areas, and the like.
Department of Fisheries and Oceans	Responsible for protection of fisheries resources.
Health & Welfare Canada	Responsible for ensuring compliance with the Public Health Ordinance.
Transport Canada	Responsible for safe operation of aircraft and boats.
RCMP	Responsible for law enforcement throughout the Territories.
Territorial Government	
Renewable Resources	Responsible for wildlife management. New access to remote areas of special concern.
Local Government	Issue Land Use Permits, Quarrying Permits and surface leases on Commissioner's Lands.

Final Clearance of a Permit

Within 60 days of completing work authorized by a Permit, an operator must submit a final plan showing all lands used during the operation. This plan is submitted to the Land Use Engineer.

An inspection will be arranged, to ensure that all Permit conditions have been met. If the Inspector is satisfied, clearance will be issued and the operator's obligations under that Land Use Permit terminate.

If all conditions of the Permit have not been met, the operator must correct any deficiencies. Operators must return to the site and restore it properly before a Permit is cleared.

Debris left at an abandoned camp. A Permit will not be cleared until this debris has been disposed of.

Common Land Use Permit Conditions

Permits are granted with conditions attached. These conditions have been developed on the basis of past experience, and are designed to protect the environment. Conditions may require the use of certain techniques, or may prohibit use of others. Some requirements of the Regulations and conditions attached to Permits and the rationale behind them are outlined below.

Archaeological Sites

Damage to known archaeological sites is avoided by prohibiting land use activities near such locations. If previously unknown archaeological sites are found, work must be suspended.

No Debris In Streams

Depositing material such as gravel, soil, waste rock or debris in streams or lakes is prohibited. This ban protects aquatic life from damage.

Fuel Location

Fuel and supply caches must be located above the high water mark of streams and lakes. The Permit will specify how far from the shore a dump must be located. This distance will vary, depending on the size and contents of the cache.

Empty fuel drums. If all the bungs had been replaced in the drums, this would be an acceptable storage method.

Small Fuel Caches

Even if a Permit is not required, the Land Use Engineer must be advised in writing whenever more than 400 litres (2 barrels) of fuel are cached. They must be told where the cache is, what it contains, and when it will be removed. All fuel containers should be clearly marked with the operator's name. This allows identification of the responsible party if abandoned containers (full or empty) are found.

Trail Construction

Where ground access is required, operators are expected to use existing trails. If new trails are needed, they should be no more than 10 m wide. These conditions prevent the building of too many or excessively wide trails in an area.

An improperly closed dump. Animals have begun spreading garbage around.

Brush Disposal

Acceptable brush disposal methods are specified in a Permit. Approved methods vary, but piling debris or leaving leaners in standing timber is prohibited. Conditions are applied to limit fire hazards, prevent outbreaks of forest pests and diseases, and to protect human safety.

Erosion Control

If trails cross areas where water and/or wind erosion could be a problem, operators are required to use appropriate control measures. For example, sandhills must be avoided whenever practical.

Permafrost Protection

In some winter operations on permafrost, it is necessary to fit bulldozers with "mushroom shoes". These protect the ground surface by limiting scalping and gouging, thus maintaining the insulating ground cover.

Waste Disposal

Measures specified for solid waste disposal vary with local conditions. Acceptable methods include incineration, landfill and backhauling. All methods have several objectives, including limiting disease at a camp, minimizing attraction of wildlife, avoiding blowing garbage,and reducing the chances that improperly tended garbage fires will start forest fires.

Equipment Removal

Once a land use operation is completed, all buildings, equipment, machinery, materials, fuel drums and similar items must be removed.

Restoration

An operator must restore disturbed areas so they can return to approximately pre-operation conditions. All sites must remain stable after operations are completed.

A temporarily closed camp. All supplies and equipment have been removed or stored in a secure location.

Timing of Operations

Land use activities may be forbidden in certain seasons. This restriction protects wildlife during critical periods, and protects sensitive terrain, especially during breakup.

Location and Equipment

Permit applications must specify the areas to be used and the equipment to be employed during a land use operation. Any changes must be approved by the Engineer. These restrictions help ensure that operations do not grow in an uncontrolled fashion, and ensure that more damaging types of equipment are not substituted after an operation is approved.

Spill Reports

Spills of chemicals or petroleum products that exceed specified limits must be reported promptly. This condition ensures that spills are cleaned up promptly.

Display Permit

A copy of the Permit and conditions must be posted at the work site to which it applies. This is intended to make all workers aware of the conditions applied to an operation.

PART 2
MINIMIZING ENVIRONMENTAL DAMAGE

Aerial Operations

Low-flying aircraft can cause caribou to flee, resulting in injury or the waste of energy which may lead to death.

These guidelines may be difficult to observe during aerial surveys, since there is little flexibility in the routing or altitude of such flights. In those instances, careful scheduling will be necessary to minimize disturbance of animals. Supply and work party shuttle flights are much more flexible in their routing, so they can conform to guidelines.

Sensitivity to disturbance varies greatly between animal species, as well as within a species. Some animals 'freeze' while an aircraft is visible, then flee after it disappears. Others may flee immediately. Occasional minor disturbances may not affect animals, while repeated ones may cause animals to leave an area.

Disturbance can have many effects on wildlife. Caribou may suffer injuries or waste energy while running from an aircraft. Wasting energy is a serious problem for wildlife in northern Canada, particularly in winter when food is often scarce. If animals cannot replace wasted energy, they may die before spring. Other problems that may result include separating cows and calves, and causing animals to desert the best ranges.

Caribou are present much of the year in large areas of both Territories. Never overfly caribou below 500 m, and do not circle a herd repeatedly, even above this altitude. Avoid landing and taking-off near major water-crossings and calving areas while caribou are present.

Restrictions on operating altitudes and seasons should also be observed in areas frequented by sheep or muskox. Calving and nursery areas, and winter range are especially sensitive locales.

Aircraft flights may cause birds to leave their nests temporarily, exposing eggs or young to predators, or to desert the nest permanently. Hurried departures by adults may injure eggs or young. Waterfowl may leave staging areas at the approach of an aircraft. Snow geese on their fall staging areas, such as the North Yukon Plain, flush if an aircraft approaches within several kilometres. This costs them energy and feeding time, and may reduce the amount of fat they accumulate. Fat provides the fuel needed for their migration flights. To avoid problems, aircraft should avoid staging areas by at least 3 km.

A young Peregrine Falcon. Activities near active falcon nests should be avoided.

Birds that have been disturbed can be a danger to aircraft. Falcons have been known to attack helicopters, and seabirds have 'mobbed' aircraft. A bird striking the rotor could cause a helicopter to crash.

Peregrines and other large falcons nesting in northern Canada are rare and therefore protected. Information on the location of nests is restricted, to prevent poaching. The Canadian Wildlife Service or the Yukon Department of Renewable Resources can advise operators if there are nests near a proposed exploration area.

Falcons are particularly sensitive to disturbance from mid-May through July, the nesting season. To protect them, restrict aircraft operations near nest sites to altitudes over 500 m. If activities near a nesting cliff cannot be avoided, confine work to ground parties. Even personnel on foot should not be within sight (1.6 km) of a nest for more than two hours. Extended visits may cause the parents to leave eggs chicks unattended for too long.

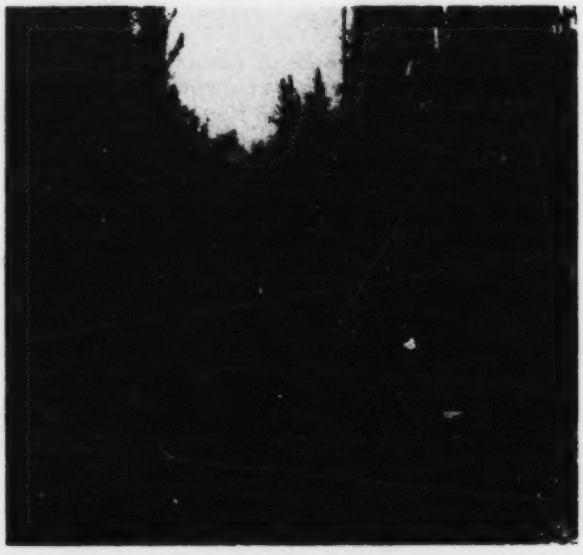
The Mackenzie Valley and the Hudson Bay coast are major bird migration corridors. To limit disturbance of migrants in these areas, aircraft should remain above 500 m in May and June, and from late August to early October.

There are large colonies of seabirds in the Arctic Islands. Flights close to a colony can cause mass panic and may provoke mobbing. Avoid colonies by at least 1 km vertically and 2 km horizontally.

There are so many potentially sensitive locations where restrictions may apply that it would be impractical to try to identify them all. Maps in the Land Use Information Series provide summaries of areas known to be sensitive at the time the maps were prepared. Operators can obtain specific information from the DIAND Northern Affairs Field Offices (listed inside the back cover), the Canadian Wildlife Service, and the Territorial Departments of Renewable Resources.

Access Trails

This section describes the construction, operation, and closure of access routes. It focusses mainly on the trails and low-class roads that are commonly used during exploration.

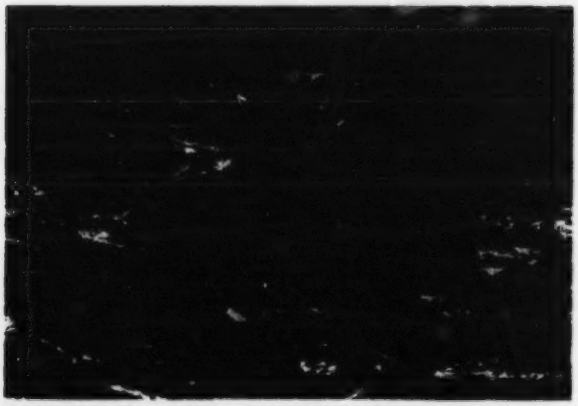


A good summer access trail. Note the minimal road width and the firm, unrutted roadbed.

Road over a sandhill. Avoid sensitive terrain along access trails.

New access is needed for many exploration programs. Good planning before construction helps avoid environmental damage that can result from poorly planned roads. It can also reduce construction, maintenance, and restoration costs.

Streamside roadbuilding. Near-stream construction should be minimized, and debris must not be piled in a stream.



A windrow. Leaving leaners and placing windrows in or against standing timber is not permitted.

In the past, most trails were routed and constructed by the lead 'Cat' driver. In some cases this practice left much to be desired: it is impossible to see all routing options from a Cat, and drivers are seldom trained to recognize any but the most obvious terrain problems.

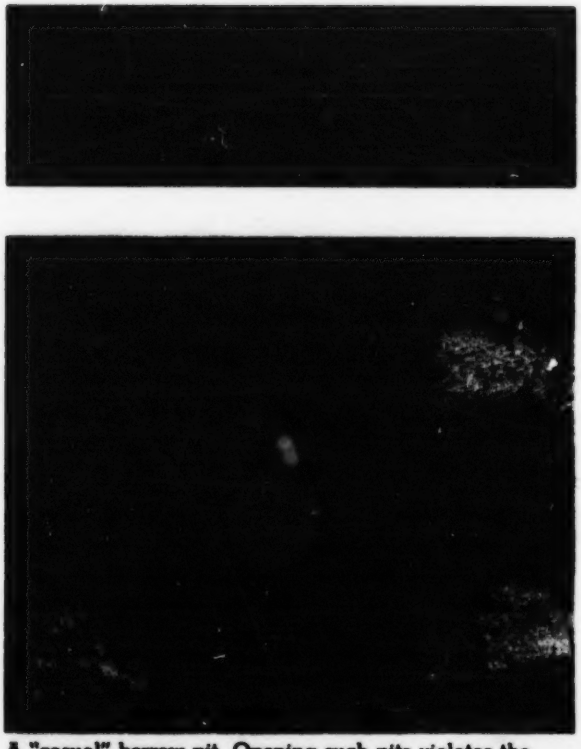
Preferred routes and alternates can be selected from aerial photos, assisted by field checking. Bogs, unstable slopes, ice-rich soils, gravel sources, good stream crossings, and stable terrain can all be identified from aerial photos.

Final route selection should depend on some or all of several factors including length, grades, amounts of cut and fill, locations of sensitive terrain, stream crossings, and wildlife habitat. Assistance in selection of the best route is available from the local Land Use Inspector.

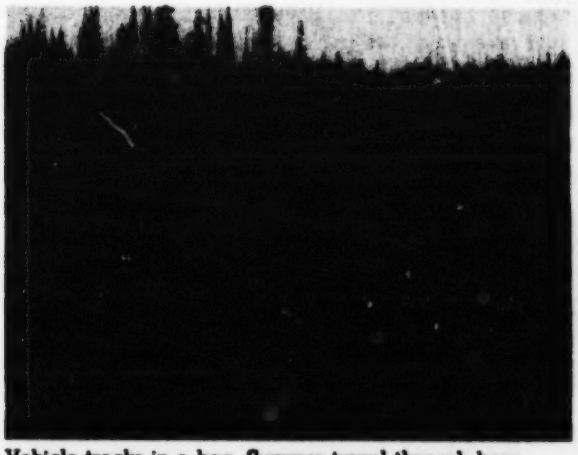
The Department of Renewable Resources is responsible for managing big game. You can help the Department in this task by avoiding areas of critical wildlife habitat when selecting routes for new trails and roads. If critical habitat cannot be avoided, use of a trail should be restricted to non-critical seasons and public access to the trail should be prevented. Without such precautions, serious damage might be inflicted on wildlife populations.

A buffer strip of vegetation should be left between roads and watercourses and lakes. Except at crossing sites, locate trails more than 30 m from stream banks and shores of lakes.

Steep and long grades encourage erosion along trails. They should be avoided, especially on summer access routes. Grades can be interrupted by short sections of reverse or flat grades, to limit erosion by running water. Take-off ditches, check dams, and similar devices also help control erosion.



A "casual" borrow pit. Opening such pits violates the Territorial Quarrying Regulations and leaves long-lasting scars.

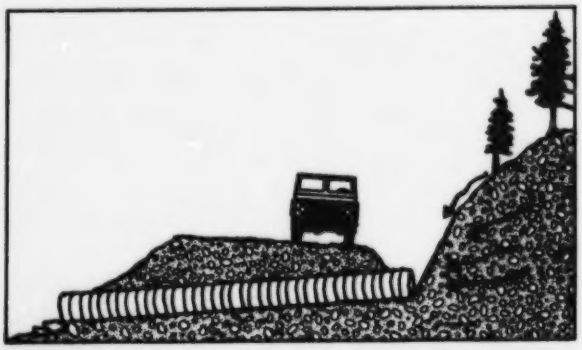


Vehicle tracks in a bog. Summer travel through bogs, even with tracked vehicles, is not recommended.

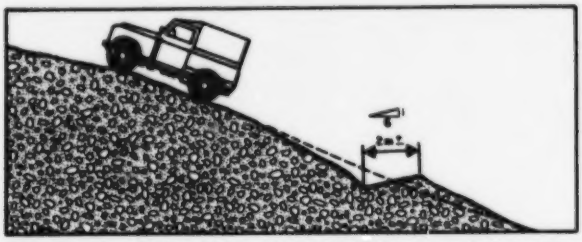
Building summer trails often requires fill. Locate possible sources of fill and obtain approval under the Territorial Quarrying Regulations to extract borrow materials before construction begins.

Although construction of summer access routes destroys all ground cover, terrain disturbance can be minimized with careful route selection. Sensitive terrain, which includes bogs, wet tundra, and areas with fine-textured soils, should be avoided whenever possible.

If permafrost is present, keep clear of areas with high-ice-content soils. They are particularly susceptible to serious degradation following disruption of the surface. In the high Arctic, where permafrost is continuous, few areas have complete ground cover. Regeneration of plants is very slow. Keep away from such especially sensitive areas, to avoid problems ranging from rutting and scarring of the landscape to ponding and landslides.



A cross drain. Such structures help limit erosion in the uphill ditch.



A water bar. It limits erosion by diverting runoff from the roadbed.

Road grades can be limited by following contours and building along benches, ridges, or valley bottoms. Where long or steep grades are unavoidable, there are techniques for limiting erosion. Flattening grades and installing cross-road drains at intervals will limit runoff velocities and volumes. Water bars can be used to divert water from the roadway. Ditches can be armored, or equipped with energy dissipating devices, such as brush check dams, to prevent gully erosion. All control structures should be inspected after each storm, and at least once a week. Maintenance can be carried out as needed.

Sheet erosion is likely to occur on bare cut and fill slopes. Steep banks may slump, especially in spring or after heavy rain when soils may be saturated. In extreme cases, slides may cover or undermine the road.

Severe slumping can be avoided by routing the road around slide-prone areas. Further protection can be gained by contouring cut slopes to less than their angle of repose. For most materials, except rock, slopes should be less than 2.5:1 and preferrably less than 3:1.

Even with careful routing, roadbuilding will require some cuts and fills. At least in the short term, special erosion control procedures will be needed. Headward erosion of gullies can be limited by rounding the tops of cut slopes so that slope angles increase gradually. In some areas, surfaces can be mulched. In other areas, hydroseeders can be used to mulch and seed surfaces, or the ground may be sprayed with a surface binder. In extreme cases, special fibre mats may be laid over the surface and staked in place. In the long term, revegetation is the best method of preventing erosion on slopes.

Mushroom shoes on a bulldozer. These limit terrain damage by elevating the blade.

Proper routing of winter roads is influenced by all the factors considered in routing summer trails, but the relative importance of various factors changes substantially. For example, streams can be readily crossed at many locations while frozen, and frozen bogs present fewer construction problems in winter than they do in summer. Conversely, exposure to sunlight is more important to winter roads than to summer trails. Winter roads should be routed in shaded areas, to minimize melting of the roadbed.

When winter roads are constructed, the ground surface is usually not levelled. Indeed, every effort must be made to protect the surface, so as to minimize erosion in summer.

The roadbed is formed by distributing, levelling, and compacting snow. All roadbeds must be deep enough and strong enough to support vehicles using the road. During use, roads must be kept in good repair.

Bulldozers used in construction of winter roads over permafrost should be fitted with 'mushroom shoes'. These limit scalping and gouging of the ground surface.

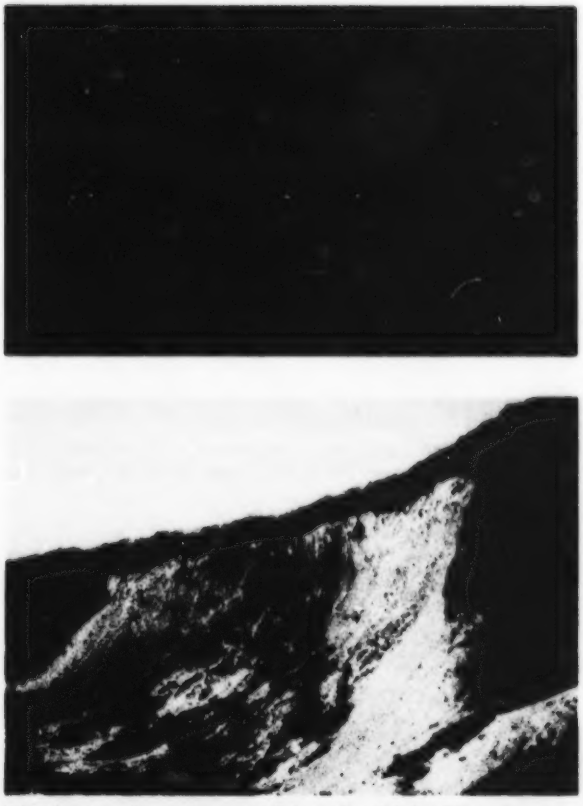
Many winter roads are built of compacted snow, and will support most tracked vehicles. A stronger surface can be created by sprinkling substantial amounts of water on compacted snow, to form an ice-capped snow road that will support wheeled vehicles.

Most winter roads cross streams on bridges made of snow or ice. Streams that do not flow in winter can be crossed by filling the channel with snow to provide a smooth crossing. For flowing streams, a strong ice bridge will be needed to support vehicle traffic. Ice can be allowed to thicken naturally, or the process can be hastened by clearing snow from the crossing area. If flooding is needed, shallow lifts (2-5 cm) are recommended. They freeze to provide a stronger, more uniform structure than deeper lifts. Bridges and runways on lakes can be built in a similar manner.

Some ice bridges incorporate logs, a practice that is not recommended because they introduce unacceptable amounts of debris into the stream at breakup. If operators construct ice bridges in this manner, all logs must be removed before breakup. For similar reasons, fill on approach ramps should contain ice and snow only.

Special precautions are needed when using ice bridges and ice runways. Vehicle and aircraft movements cause compression waves in the ice and underlying water. If speeds and spacing are not carefully controlled, especially near shore, waves may interact and damage or destroy the bridge or runway. Winds, currents, and temperature changes may also crack the ice and reduce its load capacity. Daily inspections are necessary to verify that bridges are still safe.

A compacted snow road. All available snow is used for the roadbed, so no lateral berms are present.



Massive ice deposit exposed by a landslide. Serious erosion is already evident.

Fixed-wing aircraft can be used to move equipment to a base camp. Even if a runway must be constructed, the disturbed area is small compared to that affected by access routes.

Where possible, helicopters should be used to move crews and supplies from one activity area to another. Surface disturbance is then confined to the activity areas.

When overland travel is unavoidable, restrict travel over ice-rich permafrost to the winter months, when plants are dormant and relatively resistant to damage. Even then, equipment should exert the lowest possible ground pressure, and the number of passes over an area should be minimized. Damaging the ground cover predisposes an area to permafrost degradation.

Cuts must be avoided when constructing trails over permafrost, especially where soils contain large amounts of ice. Exposing permafrost allows it to melt, and the resulting mud flows downslope. This exposes more ice, and successive periods of melting and mudflow create large gullies which are difficult to stabilize artificially. Roads near them will frequently be rendered unusable. The 'red till' areas of central Keewatin and fine-textured soils near the Arctic coast are especially susceptible to permafrost degradation.

Even where cuts are not required, building trails commonly leads to melting of the permafrost. Removal of trees and surface compaction by vehicles tends to raise ground temperatures, and leads to thawing of the permafrost.

In permafrost areas special construction methods are required to limit surface disturbance. Hand-clearing is preferred, since machine clearing can cause more surface disturbance. Felled trees are placed in the centre of the right-of-way, over the ground vegetation. Fill is end-dumped over the trees and compacted to form the roadbed. Sufficient fill should be used to insulate the ground and preserve underlying permafrost.

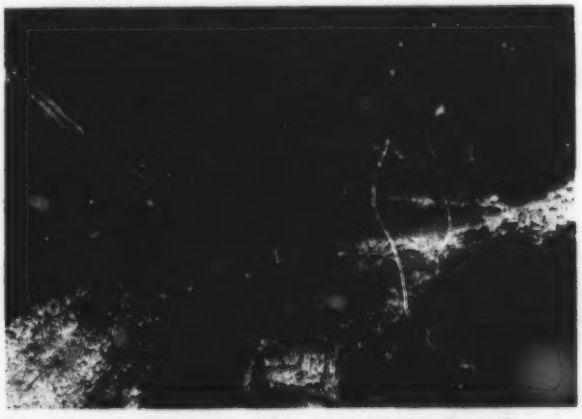
Roads may need to cross streams of various sizes. Unless care is exercised at all crossing points, fish populations may be harmed unnecessarily. Most streams are important to fish. For example, intermittent streams may serve as nursery areas during periods of flow, and streams that do not support fish carry materials into streams that do.

Depending on their size, streams may be crossed in one of three ways. Small streams can be forded along narrow, shallow stretches. Moderate-sized streams can be crossed by installing culverts, while larger streams may require a bridge. If not located properly, any of these crossing methods may cause unnecessary and unacceptable environmental damage.

Regardless of the method used, crossing points should meet certain criteria. They should be located along straight channel stretches, rather than near a bend. Banks on both approaches should be gentle, to minimize the cutting required for access. Stream gradients near the crossing should be gentle, to reduce the possibility of excessive scouring.

Fording can only be used at the discretion of the Land Use Engineer. Permission to ford is unlikely to be granted for any but the smallest streams.

A poor crossing location. In the centre of the photo the stream has cut across the point, interrupting the road.



A good crossing location. Note the straight channel, gentle approaches, and gravel base.

A poorly aligned culvert. Waterfalls block fish passage, and may erode the roadbed.

Culverts must be sized to carry the likely stream flows. They must not cause ponding above the road, or waterfalls and plunge pools at the downstream end. Proper culvert alignment and rip rapping of outfalls prevents waterfalls which can block fish passage. Gradients through culverts should be gentle, so flow rates are less than 0.4 m/sec. Higher speeds impede or stop fish passage.

Ponding, which promotes culvert icing, can be prevented by placing the culvert bottom slightly below the original streambed. Countersinking also ensures that water depth in the culvert is sufficient for fish to pass through.

Installing baffles or placing gravel in culvert bottoms will reduce flow rates. Such culverts require continual mainten- ance to remove sediment, or the bottom becomes smooth, and flow rates increase. Culverts should be inspected and maintained regularly to avoid problems.

Approach ramps for crossings should be constructed of coarse fill. When fine-textured fill must be used, it must be rip rapped to prevent washouts. All fill on ramps must be properly compacted or vehicles are likely to bog down.

Bridges are an environmentally desirable method of crossing a stream. They have the least effect on streambeds, but the cost of installation and maintenance means they are used only when other methods are unsatisfactory. Bridge abutments should not so restrict a stream channel that flow velocities increase. Abutments must resist erosion from water flowing past and over them. Bridge approaches must be built to resist periods of high water. If they span a major river, bridges must comply with the Navigable Waters Act.

If in-stream construction is necessary, diversion structures, coffer dams, and similar devices must be installed to limit the amount of silt entering the stream.

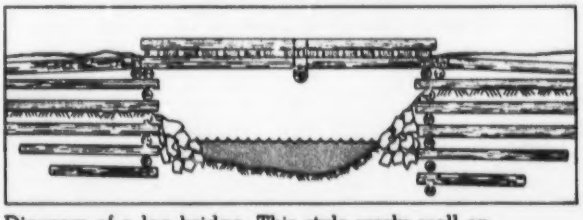


Diagram of a log bridge. This style works well on medium-sized streams.

Careful operation and maintenance of access routes are as important as proper construction.

Load limits regarding both ground pressures and total load must be observed. If the capacity of a route is exceeded, a vehicle may break through. The route will then have to be closed until the vehicle can be removed, and the damage repaired.

Small rills, soft spots in the roadbed, and similar problems should be repaired immediately. Unattended, minor problems will become worse and could render a trail impassable.

The types of vehicles used during exploration vary widely, depending on local conditions and needs. Ordinary wheeled vehicles are often used for summer operations. At times, especially where the ground is soft, tracked vehicles may be used. Neither type of vehicle is likely to cause undue damage when used on well-prepared trails.

A winter road failure. Proper route selection and road preparation might have avoided this problem.

Most vehicles can be used only on prepared trails in summer. Ordinary vehicles exert ground pressures that will injure growing plants, which can induce erosion in future. Problems may also arise if tracked vehicles are 'skid- steered'. Wheeled and tracked vehicles may cause undesirable soil compaction. If vehicles must be used off prepared trails they should be fitted with 'balloon' tires. These exert low ground pressures, and can be steered, rather than skidded.

Use of winter roads should not begin before frost has penetrated at least 15 cm along all route segments. Attempting to use them sooner is likely to result in vehicles breaking through and causing unacceptable surface disturbance. Where traffic is expected to be heavy, compacted snow roads will be needed. The roadbed should be at least 20 cm deep.

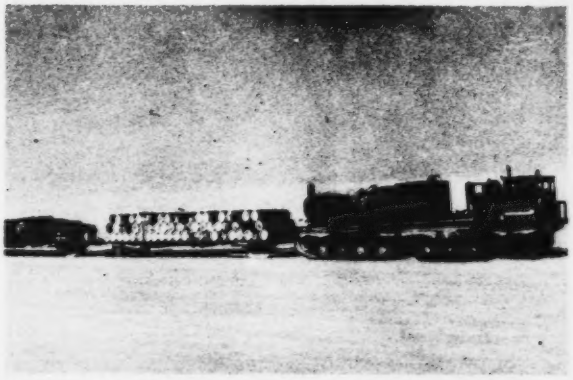
Winter roads of compacted snow require frequent inspection and maintenance. Roads carrying traffic each day should be checked every other day. Roads receiving irregular use need inspection after every 25 vehicle passes. When temperatures are above -5°C, all roads need daily inspection. All roads should be re-graded and compacted regularly.

Snow berms, such as those left by conventional snow plows, can create special problems along winter roads. They can make it difficult for animals to escape from the road when a vehicle comes along. If berms flank the road, they should be broken every 200 m, or eliminated. Berms are also a source of concentrated runoff, which may damage slopes by washing away soil, or by melting underlying permafrost. Berms can be lowered or eliminated with wing blades and snow blowers.

Tracked vehicles are most commonly used for winter transport. They provide good traction, exert low ground pressure, and cause minimal surface disturbance even off prepared roads. Balloon tires also work well under some winter conditions.

When equipment is towed on a sled,the skis are not likely to exert unacceptable pressures on dormant vegetation. Towed sleds present no slippage problems but overloaded sleds may cause tow vehicles to lose traction, and inflict serious damage on the terrain.

Winter roads must be closed before spring breakup because warm temperatures cause changes in the structure of snow. Its ability to support loads drops quickly. Careful daily inspection is necessary so that equipment can be removed before a road is closed. It may be possible, if absolutely essential, to use a road at night for a short time after day use has been suspended.



A tracked vehicle and sleds. These exert low ground pressures.

When an operation is abandoned, trails that provide access to critical wildlife habitat or remote areas should be blocked. In forested areas, windrowed trees can be used to prevent access to sensitive areas. Access trails can also be closed (put-to-bed) by backblading construction spoil across the road. Mineral soil should be redistributed to generally return contours to their original shape, and any stockpiled topsoil and organic matter should be spread over bare areas to accelerate revegetation.

When a trail is closed culverts, bridges, approach ramps, and abutments should be removed. If left without maintenance, they may become blocked or wash out. Either occurrence is undesirable. Altered flows could affect fish movements and washouts can introduce large amounts of silt into a stream.

Stream banks that were cut for approach roads, especially banks just below bends, should be stabilized. Unprotected cuts could provide a starting point for bank erosion.

After a trail has been closed correctly, only visual scars should remain and these will gradually fade with time.

Camp Sites

The location of the first camp is often the site of all later camps. But, a location satisfactory for four men for a month may not be satisfactory for a crew of two dozen conducting an extensive program over several years.

Some variables to consider when selecting a campsite are slope, wind exposure, available area, drainage conditions, and access.

Area is a major consideration. Leave enough room so that the original camp can form the nucleus from which larger camps grow as exploration proceeds. When more facilities are needed, all operational and environmental protection procedures are simplified if the camp can be expanded, rather than opening a new camp.

A flat site facilitates camp construction. When a sloping site must be used, choose slopes facing south or west. These are the warmest and driest locations. Slopes that face north or east are cooler and wetter.

Keeping excavation to a minimum will pay dividends later on by reducing restoration costs and problems when a program ends.

This camp on a north-facing slope was very wet most of the summer. Note the heavily rutted road between bunkhouses and the kitchen. Where possible keep pedestrian and vehicular traffic apart.

Try to keep footpaths and roads separate, for reasons of safety and to minimize problems with dust and noise. Roads should not go through living areas.

Campsites should be sheltered from strong winds; crew comfort and aircraft safety being the chief reasons. Gusty winds can cause serious problems for aircraft.

When camps cannot be located on dry ground, the area should be drained to create a dry site. On slopes with substantial near-surface water flows (common on north-facing slopes) it will be difficult to keep the camp dry. Flat but wet areas may be dried by clearing and levelling the area, then letting natural drainage remove excess water. Clearing the area and building a dry elevated gravel pad is more likely to be suc- cessful. In either case, organic matter and topsoil removed from the site should be used later for site restoration.

Boardwalks between buildings may be desirable in areas that receive heavy rain, or that drain slowly. Besides making camp life more pleasant, boardwalks reduce trampling of in-camp vegetation.

Access is a major factor in camp location. Where access is overland, camps must be located adjacent to the road. When camps rely on helicopters, there must be room to build a helipad nearby. Access to the pad should be along gentle gradients, to facilitate movement of supplies. If float planes provide access, camps must be located on a sheltered lake shore where planes can land and takeoff without taxiing long distances.

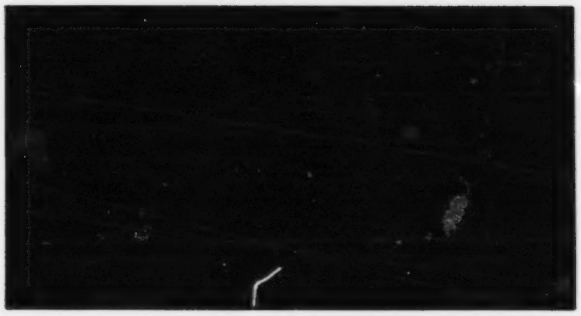
A flat but wet camp. Clearing did not dry the site, so boardwalks were necessary.

In permafrost areas, heat from bunkhouses and kitchens may thaw permafrost, particularly if vegetation has been stripped away. To minimize problems, all buildings should be elevated. Camps must be located on soils that are stable after thawing. Permafrost melting may also be limited by using surfaced walkways to discourage workers from casual wandering.

In the high Arctic, where plants are delicate and slow to recover from damage, protection of ground cover must be a primary concern. Camps should be located in areas with a minimum of ground cover.

In sandy areas, there may be only a thin "skin" of lichens over the sand. Lichens cannot withstand even light foot traffic, so protecting them is impossible. Soon after a camp is established, only bare sand will remain and blowouts may form if winds have an unobstructed sweep. Clearing should be planned so there are no long stretches open to the wind.

Campsite in a sandy area. Foot traffic has destroyed all ground cover.



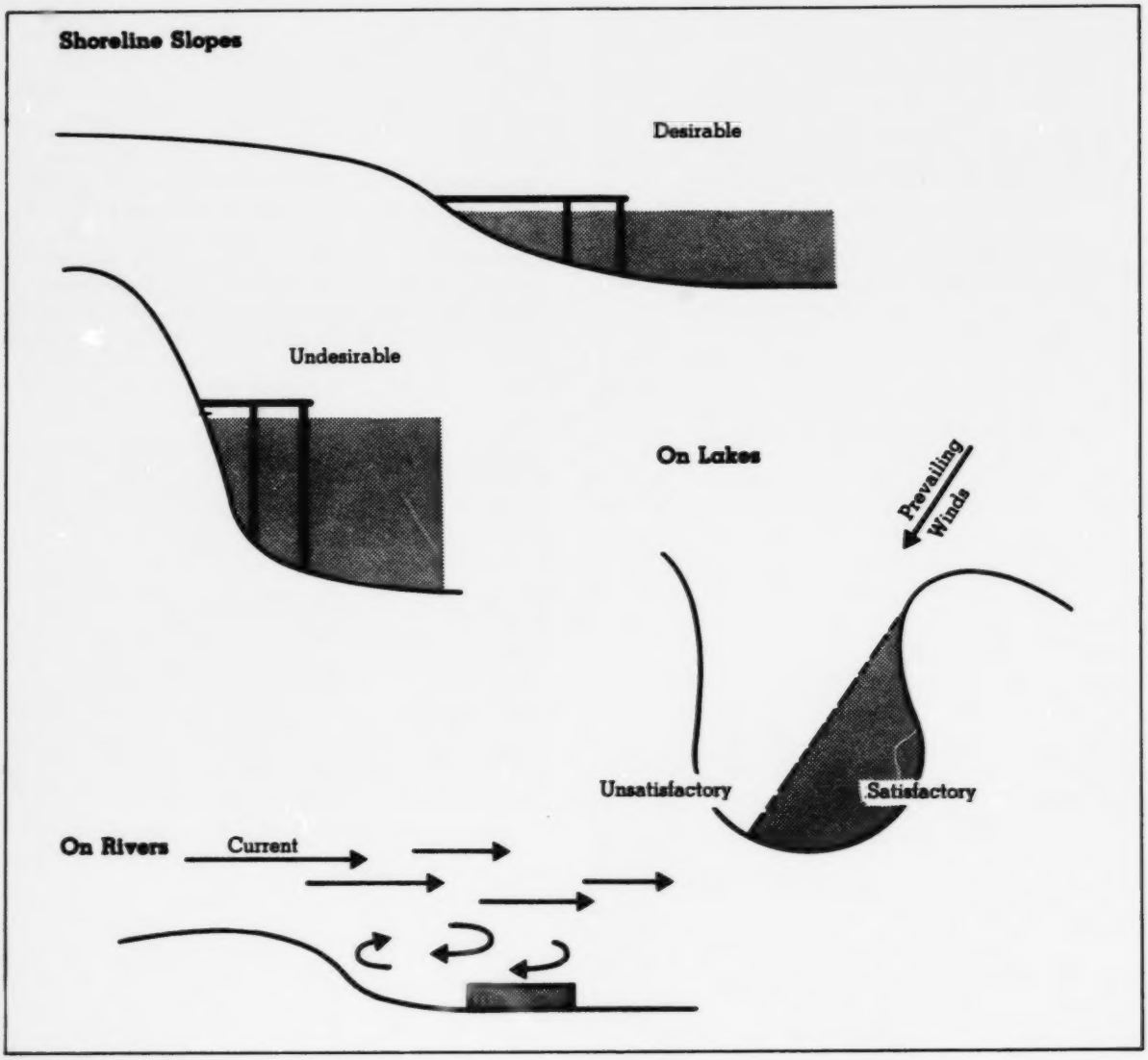
Access to the Canadian Shield is limited, so most exploration camps are supplied by air. Small boats are often used for local transport. Because boats and float planes use the same docking and fueling facilities, the following comments apply to both types of craft.

Docks must be situated and built with consideration for operational and environmental constraints. Proximity to camp, water depth, nature of the backshore, currents, and exposure to storms all influence dock location. Gentle relief across the backshore is desirable, to facilitate moving cargo to and from the dock. Docks should be located in sheltered areas, where storms are unlikely to damage them. On rivers, select quiet water areas, away from currents where floating ice and debris could damage docks. Currents are seldom a problem on lakes, but storms and drifting ice can be hazardous.

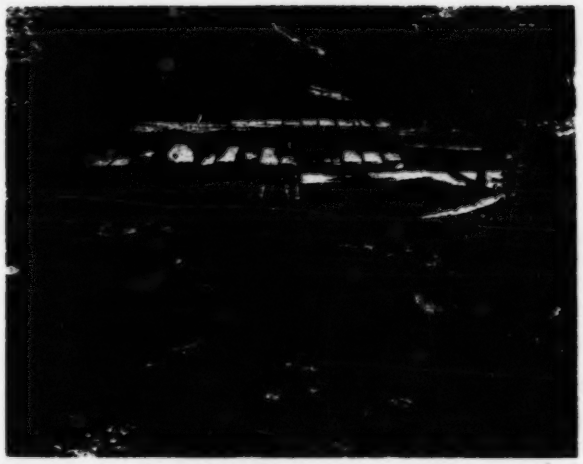
Docks should be built where water depth is adequate but not excessive. Allow for water level fluctuations during the season.

Avoid forested areas whenever possible. Where you have to build a dock along a forested shore, try to keep clearing to a minimum.

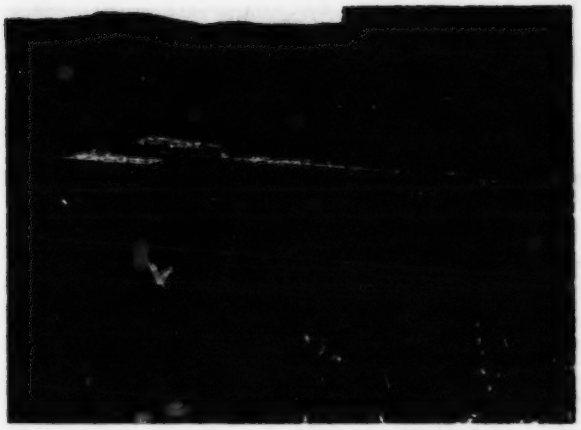
Where the shore is steep and unconsolidated, it may be eroded by wakes from boats or planes. Restricting speeds until watercraft are well offshore minimizes this problem.



Suggested dock locations.



Poor location for a dock. The backshore is steep, and the dock is exposed to storms. When operations ceased, the dock was not removed, delaying clearance of the Permit.



Well-constructed dock, resting on clean, rock-filled barrels.

Docks must be removed before freeze-up, to prevent their destruction by ice and storms. They must also be removed when an operation is terminated. Removal should be considered when a dock is constructed, for docks that are too well anchored may be difficult to remove.

Docks may rest on foundations made of rock-filled barrels. Such docks are stable, and can be removed relatively easily. Use only clean barrels, to avoid polluting the water. Decking and stringers should be firmly attached with nails or wire. All parts of the dock should be of untreated wood.

Often it will be necessary to refuel boats and aircraft and to carry out routine maintenance at camps. These activities could pollute streams and lakes. To limit problems, service equipment on shore whenever possible. Outboards and parts from larger engines can be removed and serviced in the camp. When work is done at the dock, take care that no gas, oil, antifreeze or other toxic material is spilled into the water. Fuel should be stored at least 12 m from the shore, and transferred to fuel tanks by hose. There should be shut-off valves at both the tank and the nozzle.

Disturbance of the environment can be minimized if facilities are located in natural openings or previously cleared areas. Where appropriate clearings are not available, the areas cleared should be kept small to limit surface disturbance, and thereby reduce the erosion potential of the area. Damage can be further limited if clearing is done by hand.

Where extra clearing is needed, the boundaries should follow the edge of natural openings and forest types. Blowdown is less likely to be a serious problem with this clearing pattern than if straight lines are used as boundaries.

The area cleared for aircraft landing areas must be large enough to allow safe operation of equipment. The exact dimensions will depend on a number of variables affecting aircraft operation, including local ground conditions, winds, tree heights, loads, aircraft types, and the like.

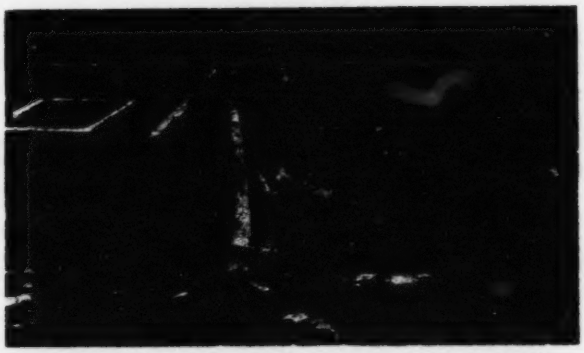
If additional areas have to be cleared, the brush must be disposed of in accordance with the terms and conditions of the Land Use Permit. The approved procedures will vary, depending on local conditions, but all disposal methods are intended to minimize fire hazards. Among the methods that may be specified are total disposal (pile and burn), lop and scatter, and windrowing and compaction.

All water withdrawals must be authorized by the Northern Affairs Program.

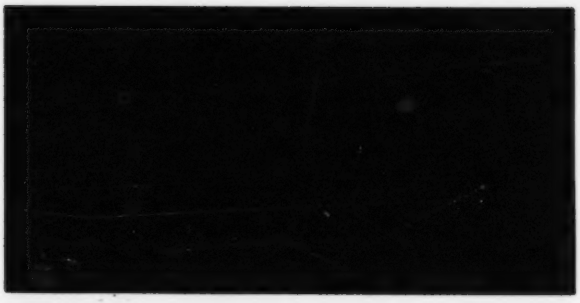
The amount of water drawn for any use must not harm fish populations. In general, withdrawals should not exceed 10% of the low flow.

It may be necessary to build a weir so water can be drawn from a pool. Weirs should not block fish movement. Fish passage is facilitated if the spillway is broad and gently sloping. Water should be at least 15 cm deep, and flow at less than 0.4 m/sec. Outlet waterfalls and plunge pools must be avoided. Remove a weir when a camp is closed.

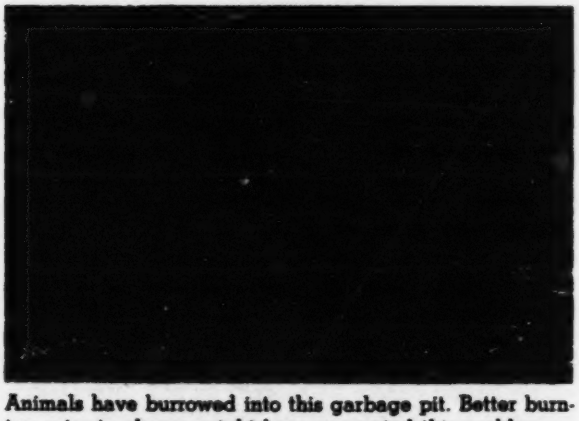
Pump stations should be at least 12 m from the shore, with only a minimum of fuel being stored there. These measures reduce the chances of fuel spills polluting the water.



A poorly constructed weir. No provision has been made for fish passage, and garbage has been discarded into the stream.



A garbage pit. Note how each day's garbage has been buried in sequence.



Animals have burrowed into this garbage pit. Better burning prior to closure might have prevented this problem.

Exploration activities generate a variety of solid wastes, most of which is wet or dry garbage. All solid wastes must be disposed of in an approved and environmentally safe manner.

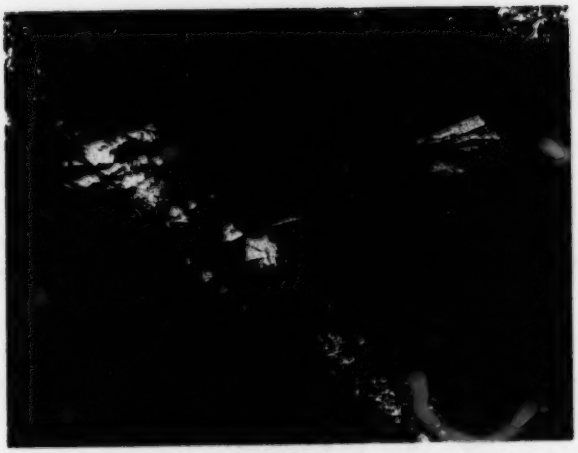
The major environmental problem with dry garbage such as paper, wood, and packaging materials is one of aesthetics: blowing paper can visually degrade wide areas. Burning in an incinerator or pit is one way of disposing of this material. Because open-pit burning is often forbidden, incineration is the preferred method.

Wet garbage, which consists mainly of waste food and food packaging, may attract wildlife, provide a breeding ground for flies, and represent a source of disease. To limit problems, food wastes must be properly disposed of, preferably by incineration. Burning in an open pit is not recommended. Because of fire hazards, it is simply not permitted at times. Also, wet garbage is unlikely to burn completely, and 'cooking' it in a fire attracts animals. If garbage cannot be incinerated it may be back-hauled on the return leg of supply flights. It will need to be carefully packaged and stowed so it does not break open in the aircraft. Ordinary garbage bags are not adequate, especially in winter. Heavy duty bags and metal or plastic garbage pails should function well. A trash compactor might be useful.

Unburnable materials such as bottles and cans can be crushed to more manageable proportions with a trash compactor. Crushing or flattening cans speeds decay by breaking the tin coating and allowing them to rust quickly.

In summer, ashes and unburnable material can be placed in a landfill area. Pits should be excavated in deep, stable, dry soils. Filling should begin at one end and progress steadily along the pit. Each day's garbage should be covered by a thin layer of soil, about 10 cm thick. When a pit is full, it must be covered by 1 m of compacted soil. This will usually be sufficient to prevent animals from burrowing into the pit.

When landfill disposal is used, some animals will visit the dump. Every effort must be made to handle and store food and garbage so that animals do not seek food in the camp itself. Animals that visit a camp should not be fed. Any predator is a potential threat to people, and limiting contact with them is the only safe course. Bears, particularly grizzlies and polar bears, are the greatest hazard. At present, there is no truly effective and safe way to scare bears away. Killing them, while certainly effective, is prohibited except in cases of immediate threat to human safety or property. Operators should contact the Territorial Wildlife Branch, who can provide current information on bear hazards in the exploration area, and advice on the best deterrent methods available.



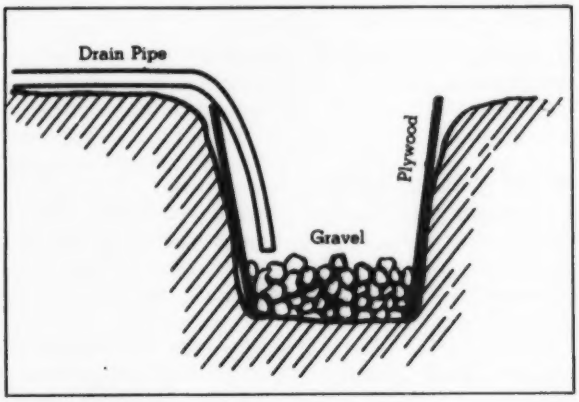
Garbage in an old privy. Garbage should not be placed in a privy. This privy was also inadequately backfilled.

Foxes, coyotes, wolves, and other predators may also visit camps. In the past, these animals have sometimes been fed and become camp pets. This practice should be actively discouraged.

Landfill disposal is not recommended in permafrost. Aside from the difficulty of excavating a pit, buried material is likely to be forced to the surface by frost action. In permafrost areas, backhauling garbage is the best disposal method. Between flights, garbage can be compacted and stored in metal pails or bins. Backhauling is also recommended in winter, for landfill disposal is impractical in that season.

Failure to close dumps properly is a common reason why a Permit cannot be cleared on first inspection. Garbage is commonly found widely scattered shortly after a camp is closed. Operators are then required to return to the site, collect loose garbage, re-bury it, and close the dump properly.

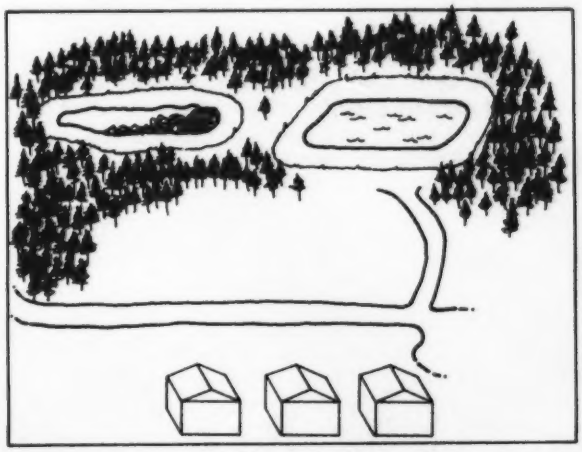
The major sources of sewage in most exploration camps are washwater and human waste. Except in the largest camps, pit privies are used for human waste, so these materials are not discharged to a waterbody. The privy should be downslope of the camp and must be downslope of the water intake. Only human waste and chemicals used to promote decay and/or reduce fly populations should be put in privies. When pits are full, they should be covered with at least 30 cm of thoroughly compacted soil.



A kitchen sump

Special problems may be experienced with privies in permafrost areas. In such areas, it may be necessary to treat the waste and discharge the effluent. Which type of treatment is effective and practical depends on details of camp size, access, soil conditions, and receiving waterbodies for effluent. Whatever system is selected, care must be taken that permafrost or winter frost will not adversely affect it. Effluent from any treatment facility must meet established standards.

Wastewater from the kitchen and washing facilities must also be disposed of in an approved manner. For small camps, the best method is probably to discharge the wastewater to a kitchen sump located at least 15 m from any waterbody. Sump capacity should be at least 1.3 times the maximum volume of wastewater likely to be discharged. The bottom of the pit should be filled with coarse gravel, and the sides shored up to prevent erosion and collapse of the pit. Washwater must not be discharged directly onto the shore or into a waterbody. In large camps, washwater can be handled by sewage treatment facilities.



Lagoons are an acceptable method of handling sewage in large camps.

It may be prudent to clear a fire guard around camps in forested areas. The width of fire breaks should be determined in consultation with staff of the Northern Affairs Program. Special efforts should be made during clearing operations to protect ground vegetation. In sensitive locations serious erosion can occur in poorly cleared fire breaks.

Minimize the danger of fire by taking such precautions as mounting spark arrestors on incinerator stacks and motorized equipment. Open pit burning should be avoided, especially when the fire hazard is high.

Adequate quantities of fire-fighting equipment must be available to deal with accidental fires. Details on the type and amount of equipment required at a camp can be obtained from any office of the Northern Affairs Program.

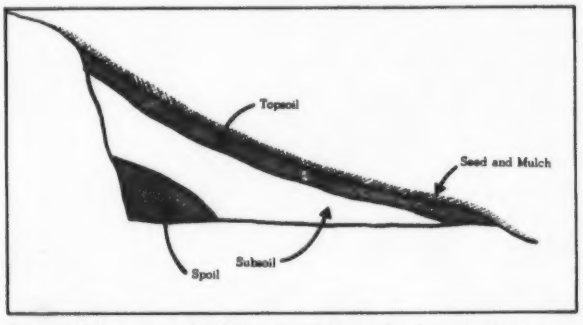
Removal of material is the most basic task. It means taking away everything from tent frames to fuel containers, and applies to all work sites and camps. Core racks are commonly left on-site, where they must be properly stored for future reference.

Camp sites must be carefully tidied. Collect any debris around the site. Depending on its nature, garbage may be backhauled, burned, or buried in the dump.

Where local topography has been changed, it may be necessary to restore the original contours, especially if slopes have been excavated and the site is potentially unstable. Recontouring can often be done with the machinery used to excavate the site originally.

Merely recontouring an area does not solve erosion problems, since exposed soil erodes easily. It may be necessary to revegetate some erosion-prone areas to limit future problems. Revegetating an area begins with providing a fertile surface dressing of topsoil and organic material. An ideal source is the organic material and soil that was removed when the area was cleared. It can supply the required growth medium as well as locally adapted seeds.

Erosion must be controlled until new growth is established. Mulch or spray with a surface binding agent to stabilize bare ground. Use contour plowing and diversion devices such as ditches, water bars, and check dams to control surface runoff.



Excavated areas should be recontoured when a site is abandoned.

In some instances in southern parts of the Territories, natural revegetation can stabilize disturbed areas.

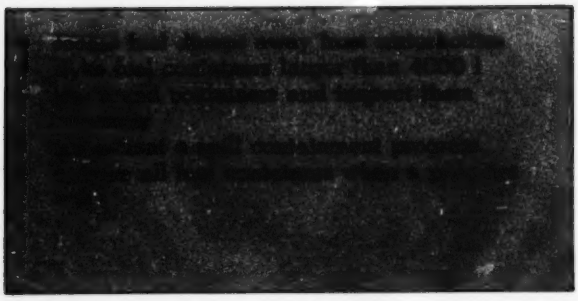
Reseeding and planting shrubs is often needed when attempting to revegetate a site. To assist establishment of seedlings, the surface may have to be cultivated and fertilized.

Certain references listed at the end of this booklet contain good descriptions of methods for seeding disturbed areas and on handling seedlings. Most of the climatic zones of northern Canada are covered.

Conditions governing plant growth are site-specific and vary widely across northern Canada. More information on revegetation procedures is continually becoming available. Consequently, detailed information on revegetation techniques has not been presented here. Operators attempting to restore sites in the Territories should obtain advice from qualified experts.

In general, the further north the site, the more difficult it is to revegetate. Similarly, low altitude sites are easier to revegetate than high altitude sites. Techniques and seed mixtures developed for northern sections of the Prairie Provinces are often successful in southern parts of the Territories. In the Arctic Islands, however, inducing revegetation is a very difficult task at present.

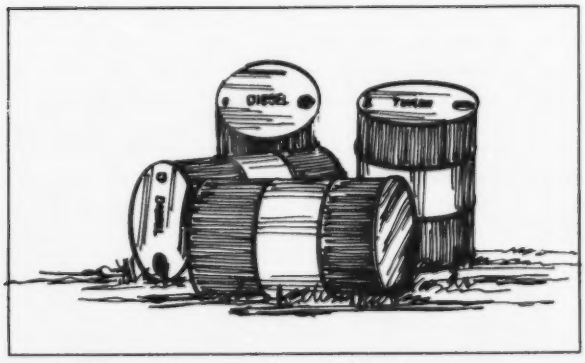
Fuel Storage



Fuel dumps range from one barrel to tens of thousands of litres. Some containers hold only a litre or two, while bladders and tanks may hold thousands of litres. The most common container is the 205 l drum. Regardless of their size or contents, all containers must be handled carefully.

Mark all fuel containers, indicating their contents and the owner's name. Handle all containers—full or empty—with care, since drums with broken seals often contain some fuel. Missing or contaminated fuel can cause major operational problems in remote areas.

Fuel caches must be set back from any waterbody and should be located on relatively flat land. Fuel containers holding less than 4000 l must be 12 m from the shore. Larger containers must be 30 m from a waterbody, and must be dyked. This maximizes chances of containing spills. In permafrost areas, dumps must be on thaw-stable sites.



Fuel containers should not be stored in a careless or haphazard manner.

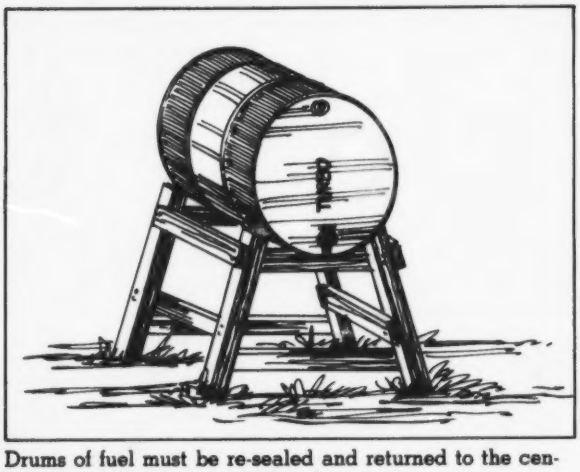
Fuel containers should not be stored near the shores of streams or lakes.

Dykes should be built of clay or other impermeable material. A liner suitable for the climatic conditions may be used if it is protected from punctures during installation. Covering the liner with carefully screened soil will help protect it during use. Dyke volumes must be sufficient to hold the contents of the largest container, plus 10% for surge and for snow or meltwater that may accumulate.

On the barrens, drifting snow fills dyked areas and may hide leaks. It may be desirable to elevate tanks protected by dykes, so that leaks can be easily spotted. Drifted snow seriously reduces the containment capacity within dykes, so containers must be inspected frequently.

All empty fuel containers must be removed from work areas and campsites. This can be difficult if drums come in on large aircraft to an ice runway and must be removed by small float planes. Volume limits the number removed each trip, so careful consideration of the types of containers used and possible removal methods will be needed. Unused fuel must also be retrieved when an operation is shut down.

Temporary Closure



Drums of fuel must be re-sealed and returned to the central store when a camp is closed.

Many exploration camps are used for only part of the year, and much material is left on-site for the next field season. If material is properly stored, environmental or property damage is unlikely to occur while the camp is empty.

Equipment can be protected from damage by storing it in secure, inaccessible locations. Tents and other structures should be taken down, but tent frames can stay up. Food should be removed and non-perishable items stored in a weather-tight building. Docks should be removed from the water and stored above the ice-scour line.

Fuel drums must be secured by removing nozzles and hoses, re-sealing them, and returning them to the main fuel store.

Garbage must be properly disposed of when a camp is closed.

Drill Sites

String marker in a boreal forest. All non-biodegradable markers should be removed when a program ends.

Extensive surveying may be needed for accurate placement of drill holes. In forested areas, survey lines of limited width, usually about 1.5 m, are cleared. Hand clearing is preferred, because that minimizes erosion. Felled trees can be lopped and scattered.

Flagging, string, and other markers used along the lines should be removed after work finishes. If removal is not possible, markers should be biodegradable, so those that are left behind will decay quickly. Cotton string is preferable to nylon.

Access roads on a northern mountainside. Pre-planning might have reduced the number of roads needed.

Clearing and levelling of drill platforms is often required. The areas levelled should be no larger than necessary, for erosion may begin at disturbed areas. Felled trees can usually be disposed of by lopping and scattering.

Where drills are transported by vehicles, access trails should be built as described earlier. On mountainsides, a network of switchbacking roads may be needed to reach all drill sites. Careful planning will limit their length and number. Fewer roads reduces operational costs and erosion problems, and simplifies site restoration if an area is abandoned. In some instances, construction of roads may not be permitted. In those cases, it will be necessary to use air-transportable equipment.

Before water can be drawn for drilling, authorization must be obtained from the Northern Affairs Program. In some cases, water is piped long distances to a drill site. Water lines should be routed around sensitive terrain, and should be dismantled when operations are suspended. Damaged segments of water pipe must be disposed of in designated dumps.

Before drilling begins, the Northern Affairs Program must approve the drilling fluids and the disposal procedures to be used.

Various materials are added to water to aid drilling. Salt prevents freezing when drilling through frozen ground. Lubricating agents improve cutting, and ease rotation of the drill stem. Other materials are used to plug porous rock.

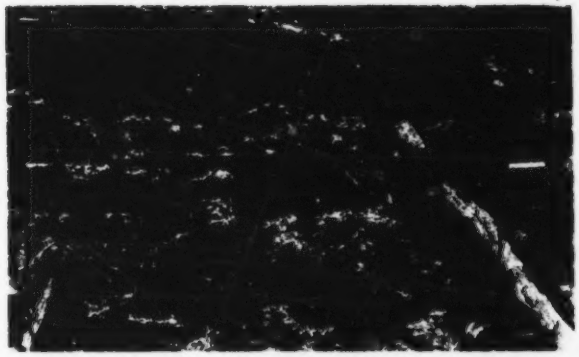
Information is lacking regarding the toxic properties of many diamond drilling additives. Most of those that have been tested proved highly toxic to trout and other fish. Use of such additives is usually prohibited. When suitable non-toxic additives are known, their use is recommended. When using additives that have not been shown to be non-toxic operators should reduce the amounts used by recycling the fluid.

Most drilling fluid is harmful to fish. Discharging it directly into waters containing fish is not permitted. Some fluids may be treated, and others discharged into swamps where toxic materials will be degraded. At the least, it will be necessary to thoroughly dilute toxic fluids before discharging them. In exceptional cases, it may be necessary to contain waste fluid in a sump. The Water Use Authorization will contain specific conditions on fluid disposal.

Drilling fluid and cuttings are often released on the ground. After the water evaporates or flows away, the rock cuttings remain. Even if the residue contains no toxic materials, the cuttings smother ground vegetation. The area affected should be minimized.

Drill crews sometimes discard broken tools, drill pipe, and other scrap material at a drill site. This is unacceptable; scrap must be collected for disposal at a designated dump.

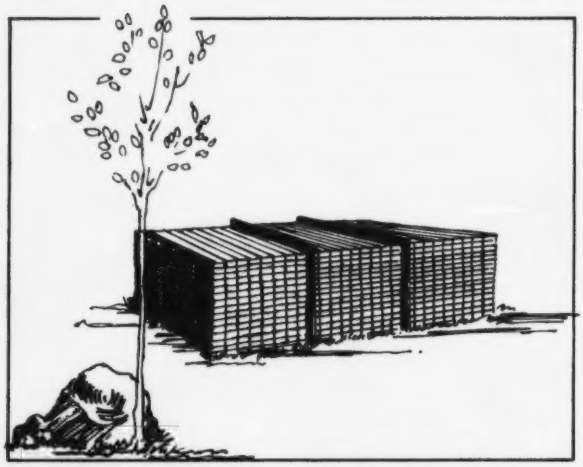
Regulations require that drill holes be plugged after completion. Frequently, this is done inadequately by leaving a piece of drill stem in the hole or by stuffing a branch of convenient size into it. Safer methods include grouting the hole, piling rocks over it, using properly sized logs, or using commercial plugs. Such plugs are unlikely to cause problems in the future.



Abandoned lengths of pipe. All debris must be removed from drill sites.

Rock cuttings around a drill hole. Much ground vegetation has been smothered. Plugging of this drill hole is unsatisfactory.

Some cores can present special environmental hazards. For example, heavy metals may leach from mineralized cores that are left exposed. Cores should therefore be covered, and storing them in covered sheds is recommended. Cores left on-site after an operation must remain accessible to interested parties for many years.

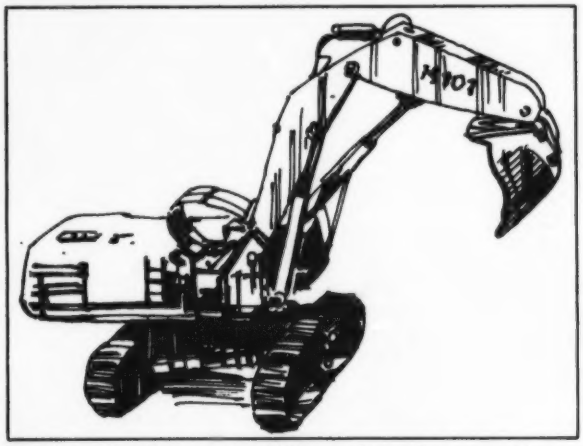


Racks of drill cores. Cores must be stored neatly, and should be covered, not left exposed to the weather.

When drill cores contain radioactive minerals, special precautions must be observed to protect workers. Operators should contact the Atomic Energy Control Board for advice on handling radioactive cores.

A number of special drilling problems may be encountered. Flowing holes are the most common problem. These must be plugged before the site is abandoned. Pockets of oil or gas, some containing hazardous amounts of hydrogen sulfide, have been encountered near Great Slave Lake. Similar problems are possible whenever sedimentary strata are drilled. Therefore, drill rigs may have to be fitted with special equipment. Crews may need air packs and 'sniff-o-meters' for hydrogen sulfide. To deal with these problems, specialized assistance is available through the non-renewable resources staff of the Northern Affairs Program.

Trenches, Test Pits, and Blasting



Backhoes are the most suitable machines for excavating trenches.

Surface disturbance occurs when excavating test trenches or pits, and during blasting. Serious problems that may arise can be minimized if special precautions are employed.

Hand excavation of trenches is desirable, for disturbance can be limited to the trench and its vicinity, whereas mechanical excavation disturbs wider areas. If trenches are dug by machines, the use of backhoes is recommended. They are more efficient, and cause less injury to the local environment than bulldozers. Equipment should be brought in on carefully prepared trails.

The first step in summer excavation should be to selectively remove and stockpile the topsoil and organic matter. Where trenches are cut through rock, blasting must be controlled, so only the desired amount of rock is dislodged. Storage, transport, loading, and firing of explosives must conform to regulations. When blasting is completed, any debris, such as used blasting wire, that may be a safety hazard must be collected and disposed of safely.

There may be restrictions on when and where blasting can be done. Generally, surface or underground blasting near waterbodies or areas of critical habitat should be minimized. Blasting should not occur near occupied bird colonies or raptor nest sites, or close to herds of big game. Fish spawning areas and over-wintering sites should be protected. Aquatic mammals, such as beavers and muskrats, also require protection. When such work is done, precautions should be taken to limit damage to fish and wildlife. Protective measures are dependent on the characteristics of each location, so site-specific information should be sought from the Northern Affairs Program.

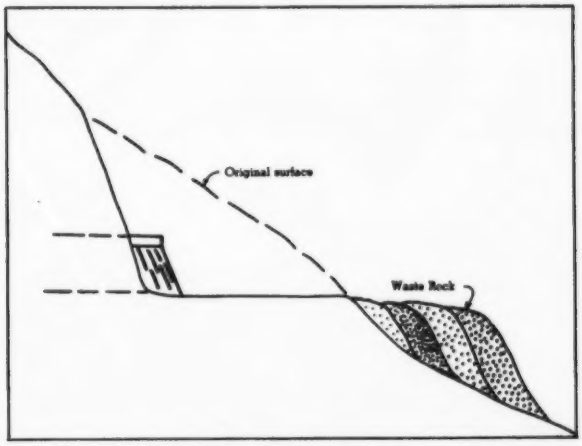
When trenches are left open, piles of excavated material should be contoured and stabilized. If a trench is backfilled, overburden should usually be replaced in the order it was excavated. Should the overburden contain dangerous materials, such as radioactive rock, that should be placed at the bottom of the trench. After backfilling and compaction is completed, the surface should be stabilized.

Serious erosion may begin at trench sites, where runoff can initiate sheet and gully erosion. This can be prevented by diverting runoff around trenches or by providing plugs of impervious material to limit flows through long trenches. Disturbed surfaces may have to be revegetated after work is completed.

Shafts and Adits

Shafts and adits may be driven during the later stages of exploration. Waste rock, ore, and water must be handled in an environmentally sound manner.

Waste rock may contain potentially harmful materials, so it should be tested before disposal methods are finalized. If waste rock contains no leachable toxic materials, it can be used to build a platform at the adit entrance. This platform must, of course, be carefully contoured for stability. If a stable platform cannot be constructed at the adit, waste rock must be dumped on flat to gently sloping land that is remote from waterbodies. Waste rock should not be dumped in streams or lakes.

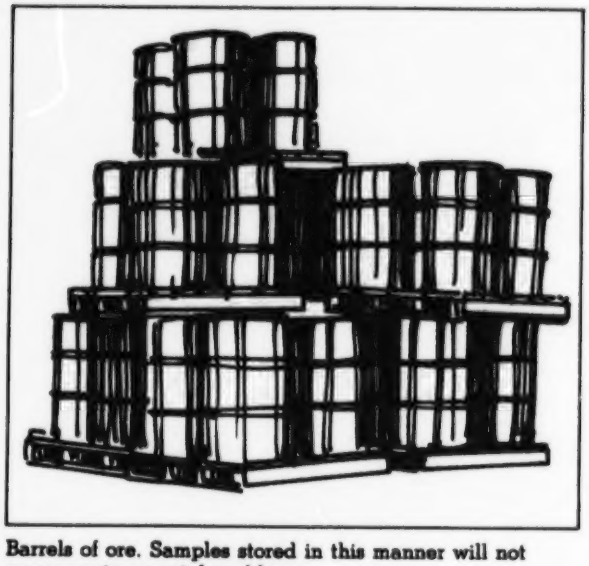


An adit platform. Waste rock can be used to build these platforms at the mouth of an adit.

Ore samples must be handled carefully, because they may contain environmentally hazardous materials, such as heavy metals. Bulk samples should be stored on dry platforms to limit leaching by rainfall or runoff. Smaller samples can be placed in covered buckets or barrels.

Substantial amounts of water are used in drilling shafts and additional water is collected during dewatering. All wastewater must be disposed of safely. The first step in safe disposal is to test the water to determine what it contains. If it contains no harmful chemicals, removal of silt may be the only treatment required before it is released to a stream or lake. Contaminated water requires treatment, the specifics of which will depend on the contaminants present. Contaminated runoff from waste rock dumps must be collected and treated and each disposal program should be developed in consultation with officials of the Northern Affairs Program.

Underground blasting causes few problems unless it is done near areas of critical habitat. Careful scheduling can avoid problems in such areas.



Barrels of ore. Samples stored in this manner will not cause environmental problems.

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